The choice E. NOTA means that none of the other answers are correct. Good luck!

1. Find the value of c so that f is continuous.

$$f(x) = \begin{cases} |x+3|^2 & x < 0 \\ c & x = 0 \\ x^2 + 9 & x > 0 \end{cases}$$

A. -9 B. 0 C. 3 D. 9 E. NOTA

2. Evaluate

$$\lim_{x \to 9} \frac{3 - \sqrt{x}}{x - 9}$$

A. $-\frac{1}{3}$ B. $-\frac{1}{6}$ C. $\frac{1}{6}$ D. does not exist E. NOTA

3. What is the shortest distance between the point $(1, 2, 3)$ and the plane $3x + 2y + z = 4$?

A. $\frac{3\sqrt{14}}{7}$ B. $\frac{5\sqrt{14}}{7}$ C. $\frac{6\sqrt{14}}{7}$ D. $\frac{9\sqrt{14}}{7}$ E. NOTA

4. What is the maximum value of $f(x) = \sin^2(3x) + \sin(x) + 3x^2 + \cos^2(3x)$ on the interval $[0, 2\pi]$?

A. $2 + \frac{3}{4}\pi^2$ B. $3\pi^2$ C. $\frac{27}{4}\pi^2$ D. $1 + 12\pi^2$ E. NOTA

5. How many positive integers are strictly less than

$$\int_{-\infty}^{\infty} \frac{1}{1 + x^2}\, dx$$

A. 0 B. 1 C. 2 D. 3 E. NOTA

6. Using two iterations of Newton's Method, approximate a root of $f(x) = x^2 - x$ with the initial guess $x_0 = 2$.

A. 1 B. $\frac{16}{15}$ C. $\frac{10}{9}$ D. $\frac{4}{3}$ E. NOTA

7. What is the area of the region of finite area bounded by the equations $y = x^2$ and $y = x$?

A. $\frac{1}{6}$ B. $\frac{1}{3}$ C. $\frac{1}{2}$ D. 1 E. NOTA

8. What value(s) of c on the interval $[0, 4]$ satisfies the Mean Value Theorem for $f(x) = x + x^2$?

A. $\frac{-1 \pm \sqrt{21}}{2}$ B. $\frac{-1 + \sqrt{21}}{2}$ C. $\frac{3}{2}$ D. 2 E. NOTA

9. Consider the differential equation $\frac{dy}{dx} = \frac{e^x}{y}$, where $y(0) = 1$. What is $y(1)$?

A. $\pm\sqrt{2e}$ B. $\pm\sqrt{2e-1}$ C. $\sqrt{2e-1}$ D. $\sqrt{2e}$ E. NOTA

10. Evaluate

$$\int_2^5 \frac{4x^2-2}{x^3-x}\,dx$$

A. $\ln(20)$ B. $\ln(30)$ C. $\ln(50)$ D. $2\ln(20)$ E. NOTA

11. A ball is shot upward from ground-level with initial velocity 40 feet per second. Assuming the only outside force acting on the ball is the acceleration due to gravity of -32 feet per second squared, what is the maximum height that the ball will reach, in feet?

A. 25 B. 50 C. 75 D. 100 E. NOTA

12. Evaluate

$$\lim_{x\to 0} \frac{\sin(x)(1-\cos(x))}{x^2}$$

A. 0 B. 1 C. π D. does not exist E. NOTA

13. Let $f(x) = x^3 - x + 1$. Find the value of $f^{-1}(x)$ at $x = 25$.

A. 2 B. 3 C. 1851 D. undefined E. NOTA

14. What is the maximum rate of change of $f(x) = \sin(x)$ on the interval $[\frac{\pi}{2}, \frac{3\pi}{2}]$?

A. -1 B. 0 C. 1 D. $\frac{\pi}{2}$ E. NOTA

15. James and Jane Richard are at the Burger Prom. To be crowned "Burger King and Queen" they must eat a number of "fat" and "lean" burgers. James can eat no "fat", and Jane can eat no "lean". James' rate of "lean" consumption from the burgers x minutes from starting is $(\sin(x) + \cos(x))$ liters/minute. At time x, Jane consumes "fat" from the burgers at the rate of $(\frac{1}{x+1} + 3x)$ liters/minute. Assuming that the burgers are made only of "fat" and "lean" how many liters do James and Jane Richard consume in the first minute?

A. $\sin(1) + \cos(1)$ B. $\frac{\pi}{2}$

C. $\sin(1) + \cos(1) + \frac{9}{2}$ D. $\frac{2\ln(2) + 2\sin(1) - 2\cos(1) + 5}{2}$ E. NOTA

16. Find $\frac{d}{dx}(4)$.

A. 0 B. 1 C. $4x$ D. indeterminate E. NOTA

17. Evaluate
$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (2 - 2\sin(x))\, dx$$

A. -4 B. 0 C. π D. 2π E. NOTA

18. Evaluate
$$\lim_{x\to\infty} \frac{x^5 + 6x^3 + 8x^2 + 5x + 1}{x^4 \sin(x) + 7x^3 + 9x^5 + 3}$$

A. 0 B. $\frac{1}{3}$ C. ∞ D. does not exist E. NOTA

19. Find the area under the curve $f(x) = x\ln(x)$ and above the x-axis from $x = 1$ to $x = e$.

A. e B. $\frac{e^2+1}{4}$ C. $e^2 - 1$ D. $e^2 + 1$ E. NOTA

20. Find $\int \sin^{-1}(x)\, dx$. Note that **C** is the constant of integration.

A. $\frac{1}{\sqrt{1-x^2}} + \mathbf{C}$ B. $\sqrt{1+x^2} + \mathbf{C}$

C. $x\sin^{-1}(x) + \sqrt{1-x^2} + \mathbf{C}$ D. $x\sin^{-1}(x) + \sqrt{1+x^2} + \mathbf{C}$ E. NOTA

21. Given that $h(x) = \frac{f(x)}{g(x)}$ and $f(2009) = 1$, $f'(2009) = 2$, $g(2009) = 3$, and $g'(2009) = 4$, find $h'(2009)$.

A. $-\frac{10}{9}$ B. $-\frac{2}{9}$ C. $\frac{2}{9}$ D. $\frac{10}{9}$ E. NOTA

22. Find the volume of the solid formed by revolving the region bounded by $y = x^2\cos(\frac{\pi}{2} - x)$, $x = \pi$, and the x-axis about the y-axis.

A. $\pi(\pi^2 - 6)$ B. $3\pi(\pi^2 - 2)$ C. $2\pi^2(\pi^2 - 6)$ D. $6\pi(\pi^2 - 2)$ E. NOTA

23. Evaluate
$$\int_{-\infty}^{\infty} \frac{dx}{(x^2+1)^2}$$

A. $-\frac{\pi}{4}$ B. $\frac{\pi}{4}$ C. $\frac{\pi}{2}$ D. diverges E. NOTA

24. Find $\dfrac{d(\sinh(x))}{dx}$.

A. 0 B. $-\sinh(x)$ C. $-\tanh(x)$ D. $\cosh(x)$ E. NOTA

25. What is the sum of the roots of the derivative of $f(x) = x^3 + 3x^2 + 4x - 5$?

A. -6 B. -3 C. -2 D. 0 E. NOTA

26. Which of the following represents the equation $x^2 + y^2 = 3$ in polar coordinates?

A. $\theta = 3$ B. $\theta = 9$ C. $r^2 = 3$ D. $r^2 = 9$ E. NOTA

27. How many integer solutions are there to the equation $3^x - x^2 = 2$?

A. 0 B. 1 C. 2 D. 3 E. NOTA

28. Given that $f(x) = \sin(x)\cos(x) + 3x^5 + 6x^8 \sec(x)$, find $\frac{d}{dx}f'(3)$.

A. 0
B. $\sin(3)\cos(3) + 729 + 39366\sec(3)$
C. $39366\tan(3)\sec(3) + 104976\sec(3) + 1215 - \sin^2(3) + \cos^2(3)$
D. $1620 + 244944\sec(3) + 39366\sec^3(3) - 4\cos(3)\sin(3) + 209952\sec(3)\tan(3) + 39366\sec(3)\tan^2(3)$
E. NOTA

29. Find the sum of the squares of the roots of $f(x)$ where:

$$f(x) = \int (6x^2 - 2x + 2)dx$$

Assume the constant of integration is zero for this problem.

A. $-\frac{7}{4}$ B. $-\frac{3}{2}$ C. $-\frac{5}{9}$ D. $\frac{1}{2}$ E. NOTA

30. Newton's Law of Cooling states that the rate of change of the temperature of an object is proportional to the difference between its own temperature (T) and the ambient temperature (T_a). That is,

$$\frac{dT}{dt} = k(T - T_a)$$

A coin at $90°F$ is placed in a bucket of water at $30°F$. Assume that the bucket of water remains at a constant temperature of $30°F$. After half an hour the temperature of the coin is $60°F$. According to Newton's Law of Cooling, what will be the temperature of the coin after another half hour?

A. $30°F$ B. $35°F$ C. $40°F$ D. $45°F$ E. NOTA